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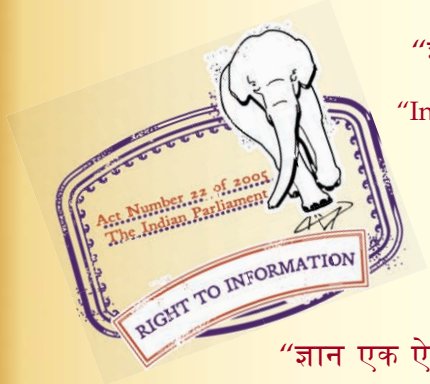

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Indian Standard

GUIDANCE FOR ENVIRONMENTAL TESTING

PART I GENERAL

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GUIDANCE FOR ENVIRON MENTAL TESTING

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Indian Standard

GUIDANCE FOR ENVIRONMENTAL TESTING

PART I GENERAL

0. FOREWORD

0.1 This Indian Standard (Part 1) was adopted by the Indian Standards Institution on 16 April 1984, after the draft finalized by the Environmental Testing Procedures Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 This standard lays down general guidance details for environmental testing. The guidance details for individual tests are laid down in subsequent parts of this standard.

0.3 This standard is largely based on IEC Pub 68-l (1982) 'Basic environmental testing procedures: Part 1 General and guidance', issued by the International Electrotechnical Commission (IEC).

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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1. SCOPE

1.1 This standard (Part 1) deals with general guidance details relating to environmental testing of electronic and electrical items.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Repeatability — The closeness of agreement between successive results obtained with the same method on identical test material and under the same conditions (same operator, same apparatus, same laboratory and same time).

*Rules for rounding off numerical values (revised).

2.2 Reproducibility -The closeness of agreement between individual results obtained with the same method on identical test material but under different conditions (different operators, different apparatus, different laboratories and/or different times).

2.3 **Combined Test — A** test in which two or more test environments act upon the test item simultaneously.

NOTE — **Measurements are usually taken at the start and at** the end of the test.

2.4 **Composite Test —** The test in which the test item is exposed to **two or more test environments in close succession and for which the times of intervals between the exposures to different** test environments are defined precisely, because they have a significant effect on the test item.

Pre-conditioning and recovery or stabilization periods are usually not performed between each exposure.

NOTE — **Measurements are usually taken prior to the start** of the first exposure and at the conclusion of the last exposure.

2.5 **Sequence of Tests — A** sequence in which the test item is exposed successively to two or more test environments. The times of intervals between the exposures to different test environments are such that they normally have no significant effect on the test item.

Pre-conditioning and recovery periods are usually performed between each exposure.

NOTE — Measurements are usually taken before and after each exposure, the final measurement of one test being the initial measurement of the next.

3. GENERAL

3.1 Environmental testing is intended to demonstrate with some degree of assurance that an electrotechnical product will survive and perform under specified environments, either by simulating the real life environment or by reproducing the effects of that environment.

3.2 The test procedures of IS : 9000* have the following aims:

a) to determine the suitability of an electrotechnical product for storage, transportation, and operation under specific environments, taking account of its expected life; and

b) to provide information about the quality of a design or of a manufactured electrotechnical product.

*Basic environmental testing procedures for electronic and electrical items.

3.3 The selection from IS : 9000* of the severity of a test procedure, or even, in part, the choice of the test itself, corresponding to a given environmental stress can be difficult. Although it is not possible to give a rule which is universally valid for all components, equipments and other electrotechnical products, relating test conditions to real life environmental conditions, it is nevertheless possible, in some cases, to establish such relations.

3.4 Consequently, this guide is restricted to an enumeration of the essential points which require to be taken into consideration when choosing a test and test severities. It should be stressed that the order in which tests are made on an item (see 2.5) can be important.

3.5 For certain tests, specific guidance is to be found in the individual standards of IS : 9001 †.

4. BASIC CONSIDERATIONS

4.1 When there is a requirement for environmental testing, the test procedures of IS : 9000* should always be used unless there is no appropriate test there included. The reasons are the following:

a) Full compliance with a test procedure of IS : 9000* is necessary to achieve the intended repeatability and reproducibility;

b) As the tests of IS: 9000* are liable to be applied to very diverse electrotechnical products, they have been designed so as to be independent, as far as possible, of the kind of electrotechnical product tested;

c) The results obtained in different laboratories may be compared;

d) The proliferation of slightly differing test procedures and apparatus can be avoided; and

e) The continued employment of the same test enables the results to be related to the results of earlier tests on items for which information about the performance in service is available.

4.2 As far as possible, the tests are specified in terms of the test parameters and not by a description of the test facilities. However, for some tests it has been necessary to specify the test apparatus.

4.3 In choosing the test procedure to be applied, the specification writer should always take into account the economic aspects, particularly where two different tests exist, both capable of providing the same information.

*Basic environmental testing procedures for electronic and electrical items.

†Guidance for environmental testing.

4.1 When the separate successive application of two or more environments does not provide the desired information, recourse should be had to combined tests (as defined in 2.3). The most significant combined tests are given in IS : 9000*.

4.5 In some cases, however, it might be necessary to have recourse to other combinations of environmental conditions. There should then be taken into account the possible difficulties:

a) in the description and in the carrying out of the tests; and

b) in the interpretation of the results; it needs to be clear, in particular, that the information obtained in this manner will be better than that which could be obtained by the application of separate successive tests.

5. -RELATION BETWEEN THE REAL LIFE ENVIRONMENT AND TEST CONDITIONS

5.1 In order to describe the test, the precise nature of the environmental conditions to which the test items are to be subjected should first be defined. However, on the one-hand it is scarcely possible to reproduce the real life conditions, which follow ill-defined laws, and on the other hand the tests would probably take as long as the life expectancy of the items.

5.2 Moreover, the conditions of operational use are not always defined. For these reasons, environmental tests are generally accelerated tests with, in the majority of cases, the real life stresses increased to give a quicker result.

5.3 The acceleration factor for a test will depend upon the electrotechnical product to which it is to be applied. For this reason, and because the relation between the required reduction in testing time and the appropriate intensification of stress is not always known, it is difficult to give a figure for the acceleration factor, and this has not been attempted.

5.4 Acceleration factors should always be chosen to avoid the introduction of mechanisms of failure which differ from those occurring in operational use.

6. PRINCIPAL EFFECTS DUE TO THE ENVIRONMENT

6.1 The principal effects on an item of exposure to an environment include corrosion, cracking, embrittlement, moisture adsorption or absorption, oxidation. These may result in a change in the physical or chemical properties of materials.

*Basic environmental testing procedures for electronic and electrical items.

6.2 The principal effects of some single environments and of resulting typical failures are listed in Appendix A. Electromagnetic fields, nuclear radiation, mould growths and explosive atmospheres are examples of environments which are not listed. Not all the environments listed have related tests in IS : 9000*.

7. DIFFERENCES BETWEEN TEST FOR COMPONENTS AND FOR EQUIPMENT

7.1 Testing of Components

7.1.1 In general, the precise environment in which the given component may have to operate is not known at the time of its design. Also, it may be used in a variety of equipment and other electrotechnical products under conditions which differ from the environment to which the equipment or other electrotechnical product is itself subjected.

7.1.2 Components are frequently available in sufficient quantities to permit different tests to be applied to several samples from different lots. The number of components tested may allow of statistical analysis of the results. It is often possible for destructive testing to be adopted.

7.2 Testing of Equipment and Other Electrotechnical Products- Test items for testing are often available only in small numbers because of their cost and very often, for complex equipment and products, there is only one sample, either complete or only a part of an assembly, available for test. Destructive testing is not, therefore, usually possible and the sequence of tests is of particular importance. In certain cases, information from tests on components, assemblies and sub-assemblies may allow to testing otherwise required to be reduced.

8. SEQUENCE OF TESTS

8.1 Introduction

8.1.1 When the effect of one test condition on the test item depends on the previous conditions to which the item has been exposed, it is necessary that it be exposed to the different environmental tests in a specified order.

8.1.2 In a sequence of tests (as defined in 2.5), the intervals of time between the exposures to different test environments are such that they normally have no significant effect on the test item. If the interval does have an influence, recourse should be had to a composite test (as defined in 2.4), in which the intervals of time between the -exposures to different environments are defined precisely, because they have a significant effect on the test item.

*Basic environmental testing procedures for electronic and electrical items.

Examples:

a) Composite test	Composite temperature/humidity cyclic [IS:9000 (Part 6)-1978*]
b) Sequence of tests	Solderability [IS:9000 (Part 18)-1981†] — followed by rapid change of temperature [Sec 1 of IS : 9000 (Part 14)-1978‡] — followed by shock [Sec 1 of IS : 9000 (Part 7)-1979§]

8.2 Choice of a Sequence of Tests — The choice of the sequence of tests as a function of the intended objective depends upon considerations which may sometimes be contradictory. The objectives of test sequences and appropriate applications are discussed below:

Objectives	*Principal Applications*
a) To obtain information about failure tendencies from the early part of the test sequence, that is by starting with the most severe tests. However, tests which result in inability of the item to resist further testing are placed at the end of the sequence.	Development testing. Generally used as part of investigations into the capabilities of prototypes.
b) To obtain as much information as possible before the item is damaged, that is, by starting with the least severe tests, for example, non-destructive tests.	Development testing. Generally used as part of investigations into the capabilities of prototypes, especially when a limited number of items is available.
c) To use a sequence of tests which will give the most significant effects; in particular, certain tests may reveal damage caused by previous tests.	Standardized type approval testing of components and equipments.
d) To use a sequence of tests which simulates the sequence of environments most likely to occur in practice.	Type approval testing of equipment and complete systems where the conditions of use are known.

Basic environmental testing procedures for electronic and electrical items:

*Part 6 Composite temperature/humidity cyclic test.

†Part 18 Solderability test.

‡Part 14 Change of temperature, Section 1 Rapid change of temperature by two- chamber method.

§Part 7 Impact test, Section 1 Shock.

8.3 Sequence of Tests for Components

8.3.1 Because of the difficulty of standardizing a general sequence of tests applicable to all types of components, appropriate sequences should be given in the relevant specifications. However, when choosing a sequence, the following considerations should be taken into account:

a) A test with a rapid change of temperature should come at the start of the sequence;

b) Tests for robustness of terminations and soldering (including resistance to heat from soldering) should be included early in the sequence of tests; and

c) Then, all or part of the mechanical tests should be performed, so as to accentuate the faults likely to have been produced by rapid temperature changes and to provoke new faults, such as cracks or leaks. Such faults are easily detected by climatic tests carried out at the end of the sequence. Unless otherwise specified, these climatic tests should be those prescribed in climatic sequence given in Appendix B of IS : 9000 (Part 1)-1977*.

The dry heat and cold phases should be applied early in the sequence of climatic tests so that the short-term effects of temperature may be recognized. The damp heat cyclic phase will introduce moisture into any cracks and the effects of this will be accentuated by the cold phase, and possibly by a low air pressure phase. The application of a further damp heat cyclic phase will introduce more moisture into any cracks present and after recovery, this may be demonstrated by changes in the electrical parameters measured.

d) In some cases, sealingtests may be used for the rapid detection of cracks or leaks;

e) A damp heat (steady state) test is often applied at the end of the whole sequence of environmental tests or, where not included in the sequence, on separate items in order to determine the long-term behaviour of the component in a humid atmosphere; and

f) Tests such as corrosion, drop and topple, solar radiation are not normally included in a standard sequence of tests and if required, should be made on separate samples.

8.4 **Sequence of Tests for Equipment and Other Electrotechnical Products**

8.4.1 Choice *of Sequence*

8.4.1.1 Whenever possible, the sequence of tests should be determined on the basis of information about the conditions of operational use.

*Basic environmental testing procedures for electronic and electrical items: Part 1 General.

8.4.1.2 When this information is not available, it is recommended that a sequence giving the most significant effects be used. A sequence suitable for most types of equipment and other electrotechnical products is given in 8.4.2. It is, however, stressed that only those tests which are significant in relation to the intended use of an equipment should be applied.

8.4.2 *General Sequence of Tests to Give the Most Significant Effects [See 8.2 (c)]* — An example of a general sequence of tests, as referred to in 8.4.1, suitable for most types of equipment follows.

Test	*Comment*
Cold	—
Dry heat	—
Rapid change of temperature	May cause mechanical stress which may make the item more sensitive to later tests.
*Shock or bump *Vibration	Causes mechanical stress which may make the item fail immediately or make it more sensitive to later tests.
Air pressure Damp heat (cyclic) Damp heat (steady state)	Application of these tests will reveal the effects of the preceding thermal and mechanical stress tests.
Corrosion	—
Dust and †sand	Application of these tests may aggravate the effects of the preceding thermal and mechanical stress tests.
†Ingress of solid bodies	—
Ingress of water, for example, rain	The tests of IS : 9000 (Part 16)-1983‡ may be used.

NOTE—Tests for damp heat, steady state and corrosion should be made on different samples whenever possible.

*The order of application of these tests may be reversed.

†No test procedure yet published in IS : 9000.

‡Basic environmental testing procedures for electronic and electrical items: Part 16 Driving rain test.

8.4.3 ***Tests for Special Applications*** — The following tests should only be specified for special applications where products are likely to be affected by such environments in operational use:

Acceleration (steady state)

Mould growth

Solar radiation

*Acoustic noise

*Ozone

*Icing

NOTE-Tests for mould growth should he made on different samples whenever possible.

APPENDIX A

(*Clause* 6.2)

PRINCIPAL EFFECTS OF SINGLE ENVIRONMENTS

Environment	*Principal Effects*	*Typical Failures Resulting*
High temperature	Thermal ageing: oxidation cracking chemical reaction Softening, melting, sublimation Viscosity reduction, evaporation Expansion	Insulation failure, mechanical failure, increased mechanical stress, increased wear on moving parts due to expansion or loss of lubrication properties
Low temperature	Embrittlement Ice formation Increased viscosity and solidification Loss of mechanical strength Physical contraction	Insulation failure, cracking, mechanical failure, increased wear on moving parts due to contraction or loss of mechanical strength and to loss of lubricating properties seal and gasket failure

*No test procedure yet published in IS:9000.

Environment	*Principal Effects*	*Typical Failures Resulting*
High relative humidity	Moisture absorption or adsorption Swelling Loss of mechanical strength Chemical reaction: corrosion electrolysis Increased conductivity of insulators	Physical breakdown, insulation failure, mechanical failure
Low relative humidity	Desiccation Embrittlement Loss of mechanical strength Shrinkage Increase of abrasion between moving contacts	Mechanical failure, cracking
High pressure	Compression, deformation	Mechanical failure leaks (failures of sealing)
Low pressure	Expansion Reduced electric strength of air Corona and ozone formation Reduced cooling	Mechanical failure, leaks (failures of sealing), flashover, overheating
Solar radiation	Chemical, physical and photochemical reactions Surface deterioration Embrittlement Discoloration, ozone formation Heating Differential heating and mechanical stresses	Insulation failure *see also* 'High temperature'

Environment	*Principal Effects*	*Typical Failure Resulting*
Sand or dust	Abrasion and erosion Seizure Clogging Thermal insulation Electrostatic effects	Increased wear, electrical failure, mechanical failure, overheating
Corrosive atmospheres	Chemical reactions: corrosion electrolysis Surface deterioration Increased conductivity Increased contact resistance	Increased wear, mechanical failure, electrical failure
Wind	Force application Fatigue Deposition of materials Clogging Erosion Induced vibration	Structural collapse, mechanical failure, See ***also*** Sand or dust' and 'Corrosive atmospheres'
Rain	Water absorption Temperature shock Erosion Corrosion	Electrical failure, cracking, leaks, surface deterioration
Hail	Erosion Temperature shock Mechanical deformation	Structural collapse, surface damage
Snow or ice	Mechanical loading Water absorption Temperature shock	Structural collapse see ***also*** 'Rain'
Rapid change of temperature	Temperature shock Differential heating	Mechanical failure, cracking, seal damage, leaks

Environment	*Principal Effects*	*Typical Failures Resulting*
Ozone	Rapid oxidation Embrittlement (especially rubber) Reduced electric strength of air	Electrical failure, mechanical failure, crazing, cracking
Acceleration (steady state) Vibration Acoustic noise Bump or shock	Mechanical stress Fatigue Resonance	Mechanical failure, increased wear of moving parts, structural collapse